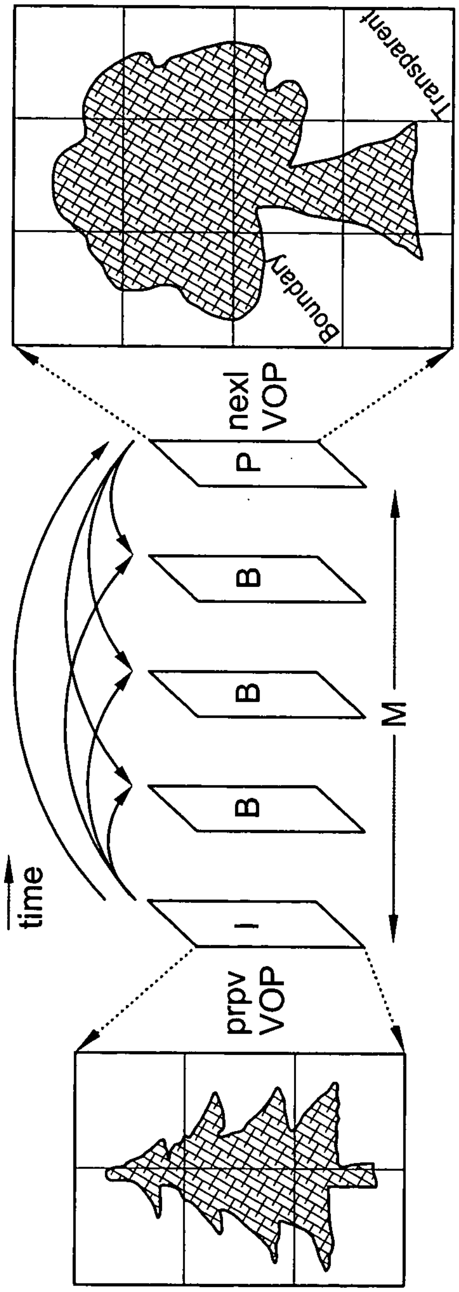


MPEG-4 sequence, content based object coding
MPEG-4 VOP time sequence

FIG. 1

```
for (all MBs)  %process all MB form P-VOP%
  fullpel_motion_estimation(current MB from P-VOP on previous  VOP)
for (all MBs) %process all MB form P-VOP%
  halfpel_motion_estimation(current MB from P-VOP on previous  VOP)
for (all MBs) %process all MB form P-VOP%
  motion_compensation(current MB from P-VOP on previous  VOP)
error_VOP = original_VOP - compensated_VOP
for (all MBs) %process all MB form P-VOP%
  code(current error MB from P-VOP)
for (all B-VOPs)
  for (all MBs) % process all MB form B-VOP%
    fullpel_motion_estimation(current MB from current B-VOP on previous  VOP)
  for (all MBs) %process all MB from B-VOP%
    halfpel_motion_estimation(current MB from current B-VOP on previous  VOP)
  for (all MBs) %process all MB form B-VOP%
    fullpel_motion_estimation(current MB from current B-VOP on next  VOP)
  for (all MBs) % process all MB from B-VOP%
    halfpel_motion_estimation(current MB from current B-VOP on next  VOP)
  for (all MBs) %process all MB from B-VOP%
    motion_compensation(current MB)
  error_VOP = original_VOP - compensated_VOP
  for (all MBs) %process all MB form B-VOP%
    code(current MB form Current B-VOP)
```

Original (VOP-oriented) MPEG-4 like source code

FIG. 2

```
for (all Mbs) % process all MB from P-VOP %
  fullpel_motion_estimation(current MB from P-VOP on previous VOP)
  halfpel_motion_estimation(current MB from P-VOP on previous VOP)
  motion_compensation(current MB from P-VOP)
  error_MP = original_MB-compensated_MB
  code(current error MB from P-VOP)
for (all B-VOPs)
  for (all Mbs) %process all MB from P-VOP%
    fullpel_motion_estimation(current MB from current B-VOP on previous  VOP)
    halfpel_motion_estimation(current MB from current B_VOP on previous  VOP)
    fullpel_motion_estimation(current MB form current B-VOPon next  VOP)
    halfpel_motion_estimation(current MB from current B-VOP on next  VOP)
    motion_compensation(current MB)
    error_MB = original_MB - compensated_MB
    code(current MB from current B-VOP)
```

Invented (MB-oriented) MPEG-4 like source code

FIG. 3

```
for (all MBs)
  full_motion_estimation(on previous VOP)
  halfpel_motion_estimation(on previous VOP)
  motion_compensation(on previous VOP)
for (all MBs)
  fullpel_motion_estimation(on next VOP)
  halfpel_motion_estimation(on next VOP)
  motion_compensation(on next VOP)
  interpolation_mode(best match previous and next VOP)
```

Original (MB-oriented) MPEG-4 like source code for B-VOP encoding in interpolated mode.

FIG. 4

```
for (all MBs)
  fullpel_motion_estimation(on previous VOP)
for (all MBs)
  fullpel_motion_estimation(on nest VOP)
  halfpel_motion_estimation(on next VOP)
  halfpel_motion_estimation(on previous VOP)
  motion_compensation(on previous VOP)
  motion_compensation(on next VOP)
  interpolation_mode(best match previous and next VOP)
```

Invented (MB-oriented) MPEG-4 like source code for B-VOP encoding in interpolated mode.

FIG. 5

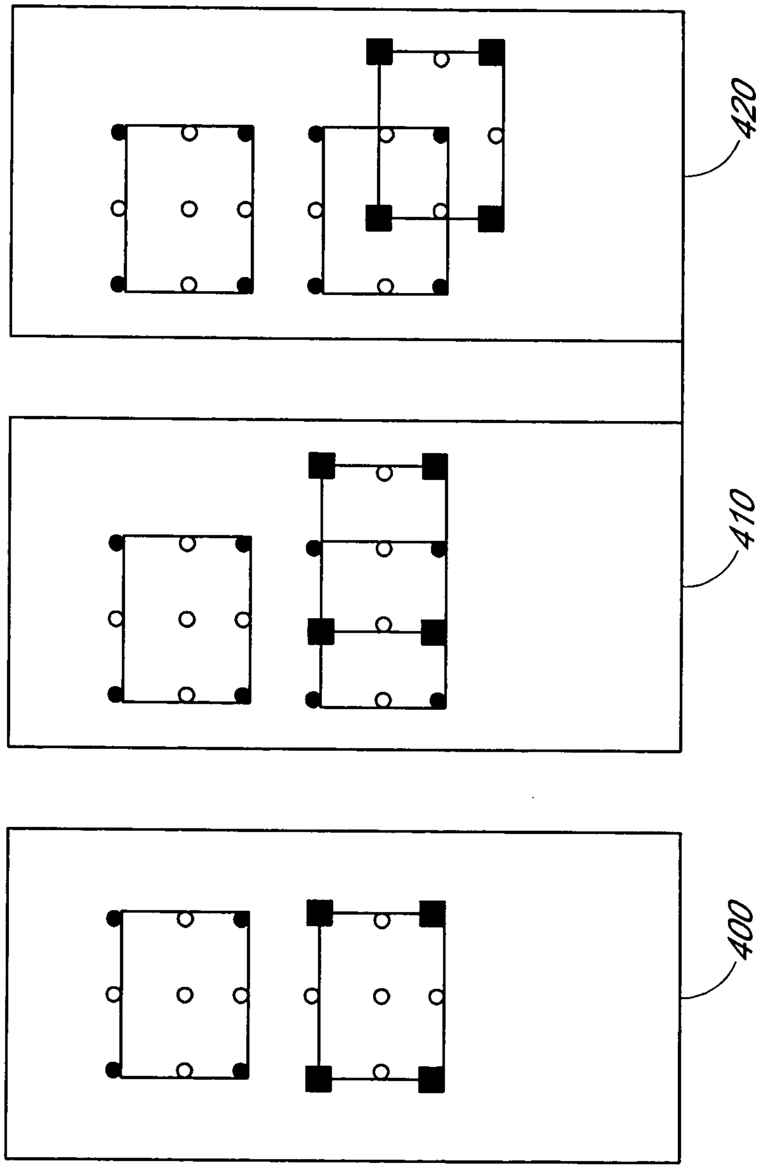


FIG. 6

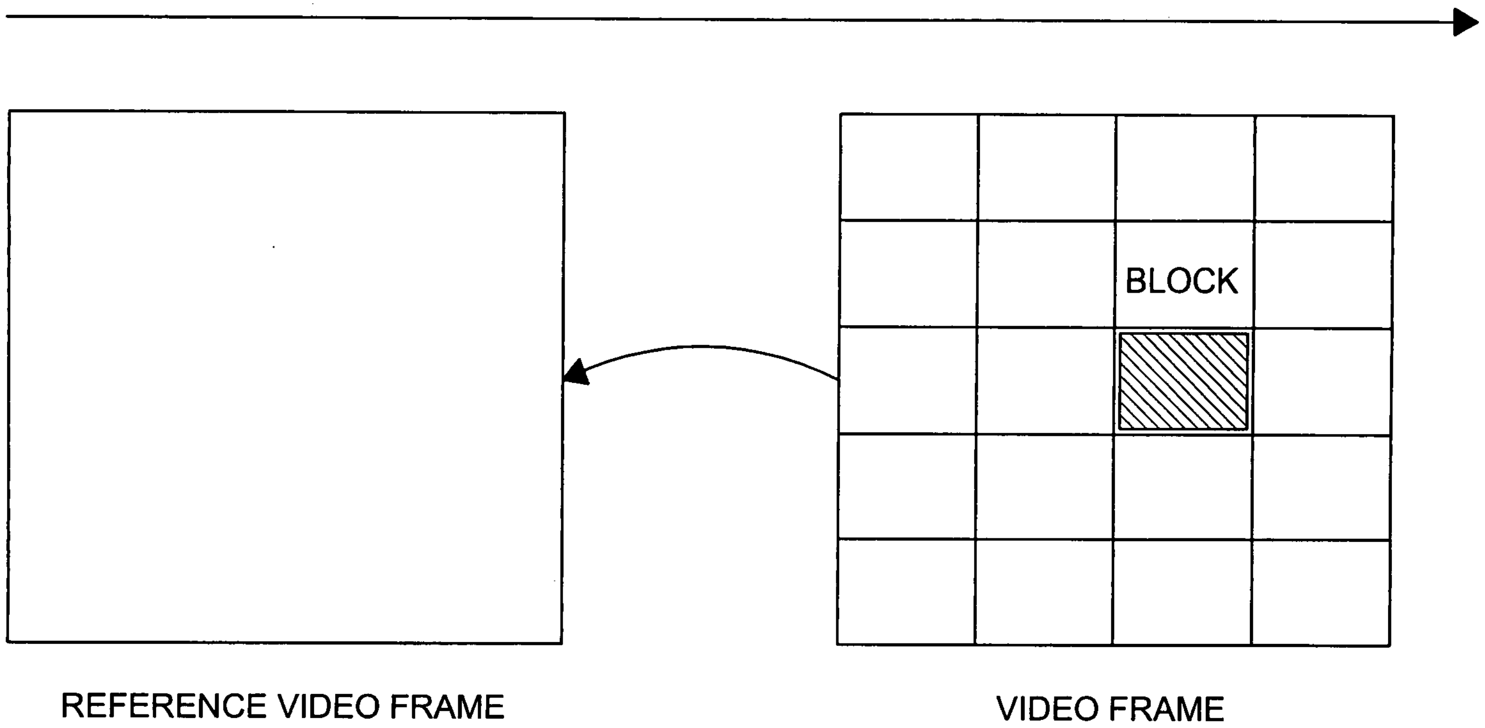


FIG. 7

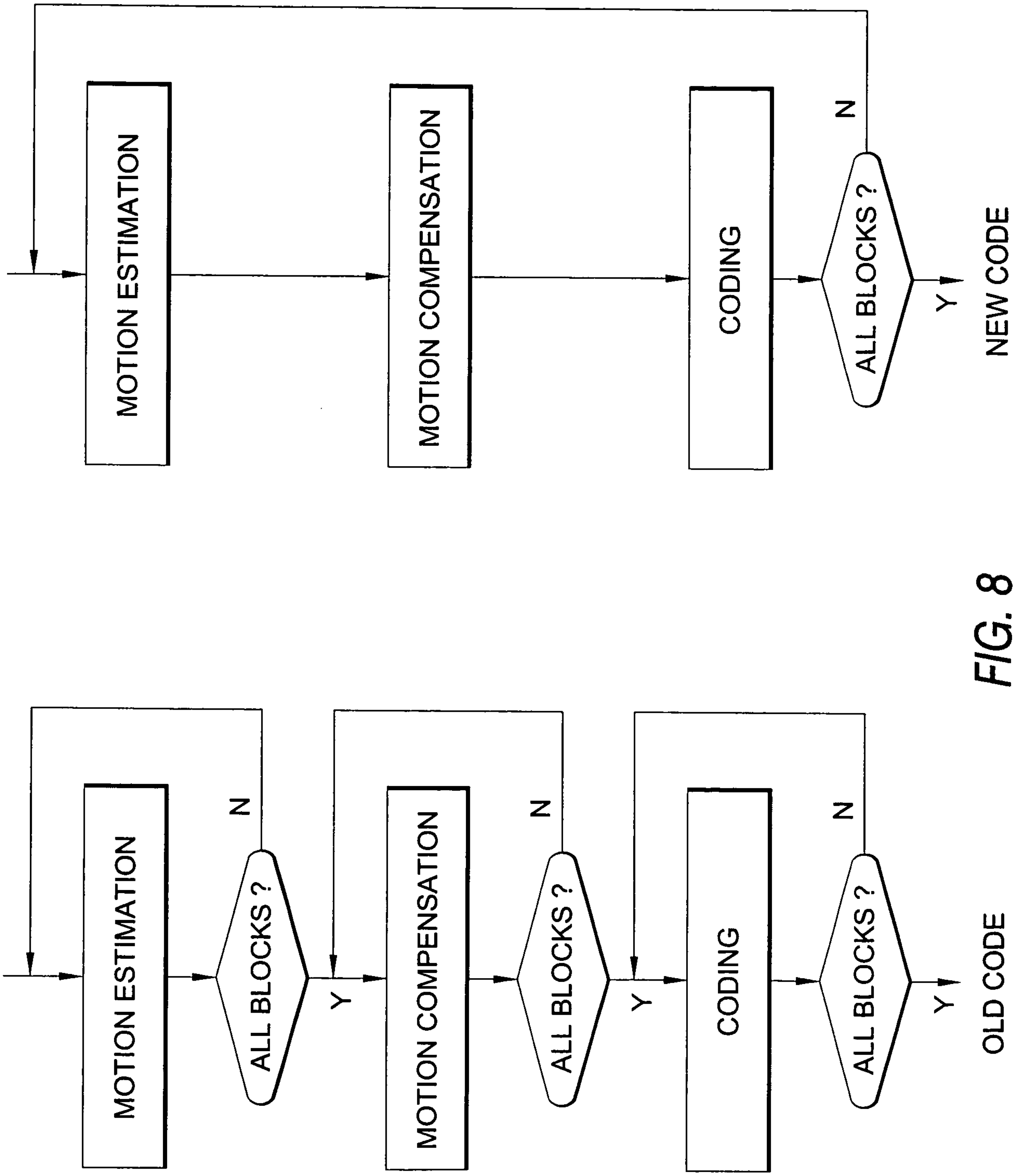

MOTION ESTIMATION
MOTION COMPENSATION
CODING
ALL BLOCKS ?
N
Y
NEW CODE
MOTION ESTIMATION
ALL BLOCKS ?
N
Y
MOTION COMPENSATION
ALL BLOCKS ?
N
Y
CODING
ALL BLOCKS ?
N
Y
OLD CODE

FIG. 8

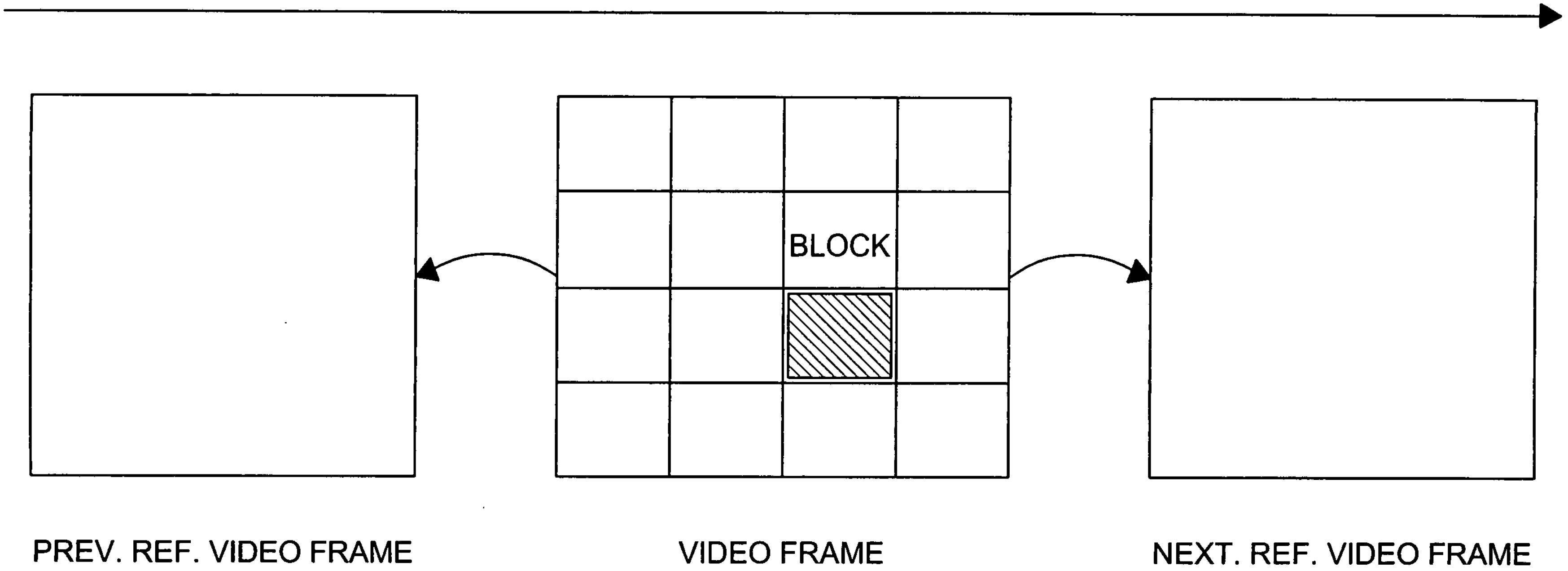


FIG. 9

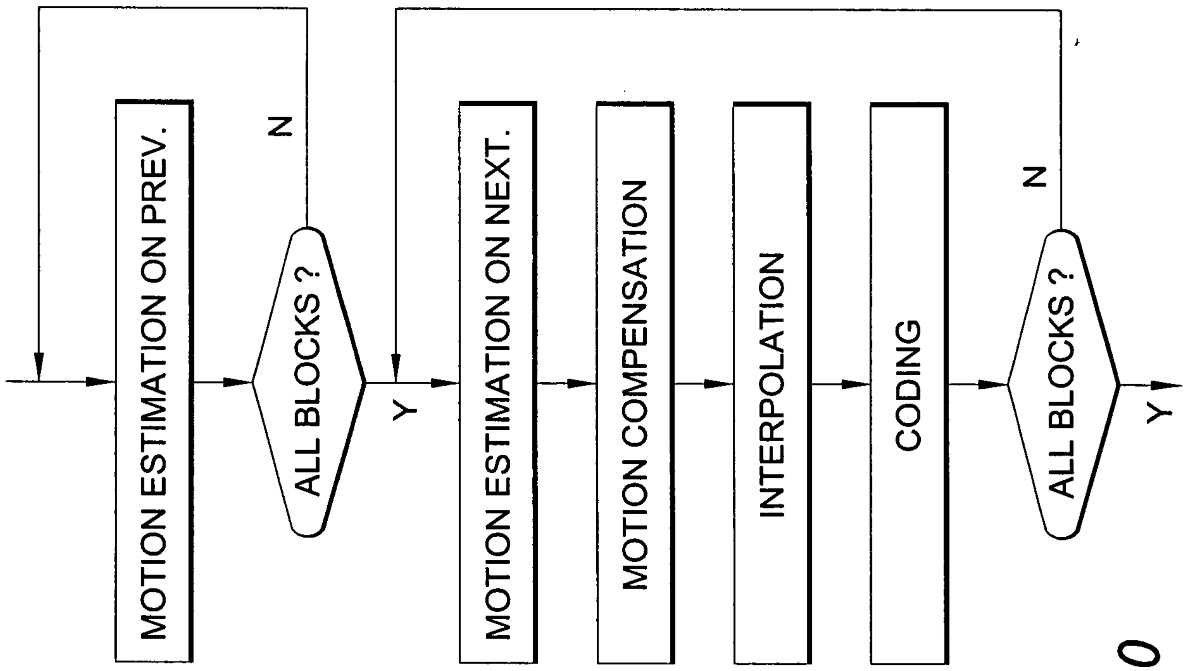

MOTION ESTIMATION ON PREV.
ALL BLOCKS ?
N
Y
MOTION ESTIMATION ON NEXT.
MOTION COMPENSATION
INTERPOLATION
CODING
ALL BLOCKS ?
N
Y

FIG. 10

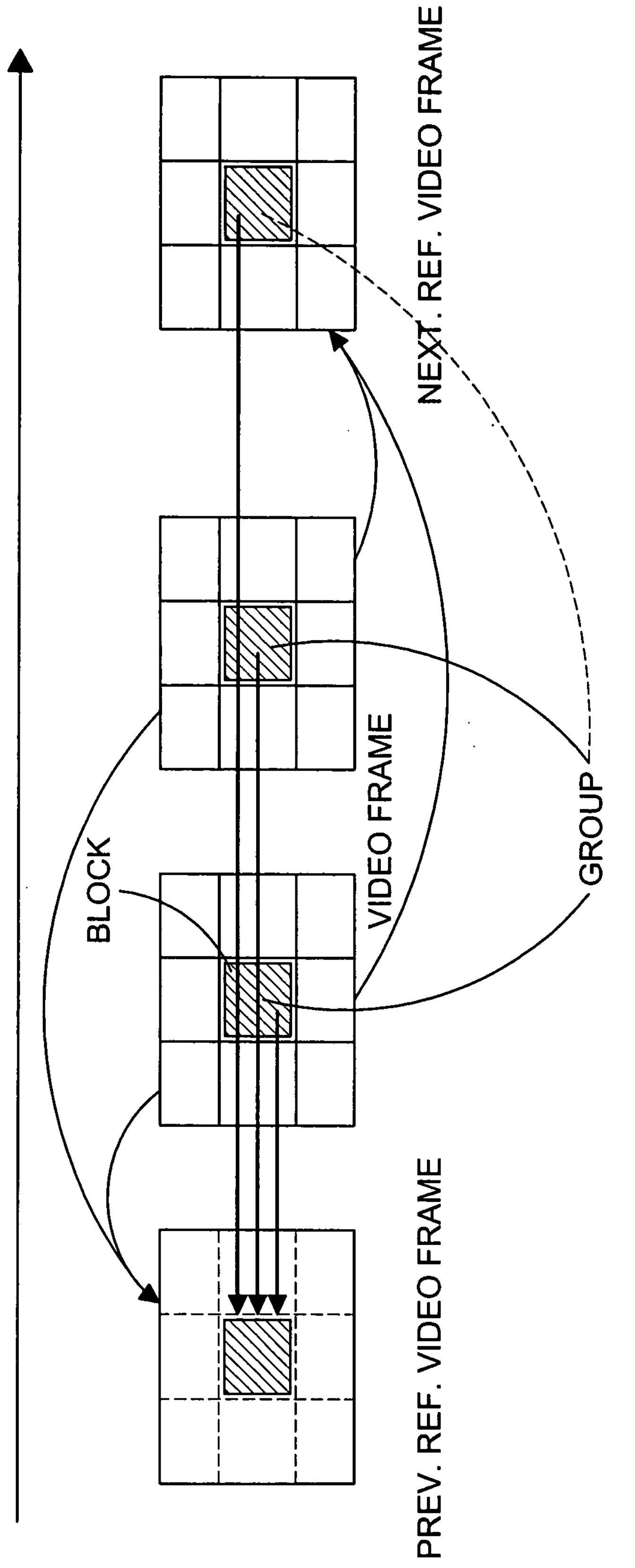

NEXT. REF. VIDEO FRAME
VIDEO FRAME
BLOCK
GROUP
PREV. REF. VIDEO FRAME

FIG. 11

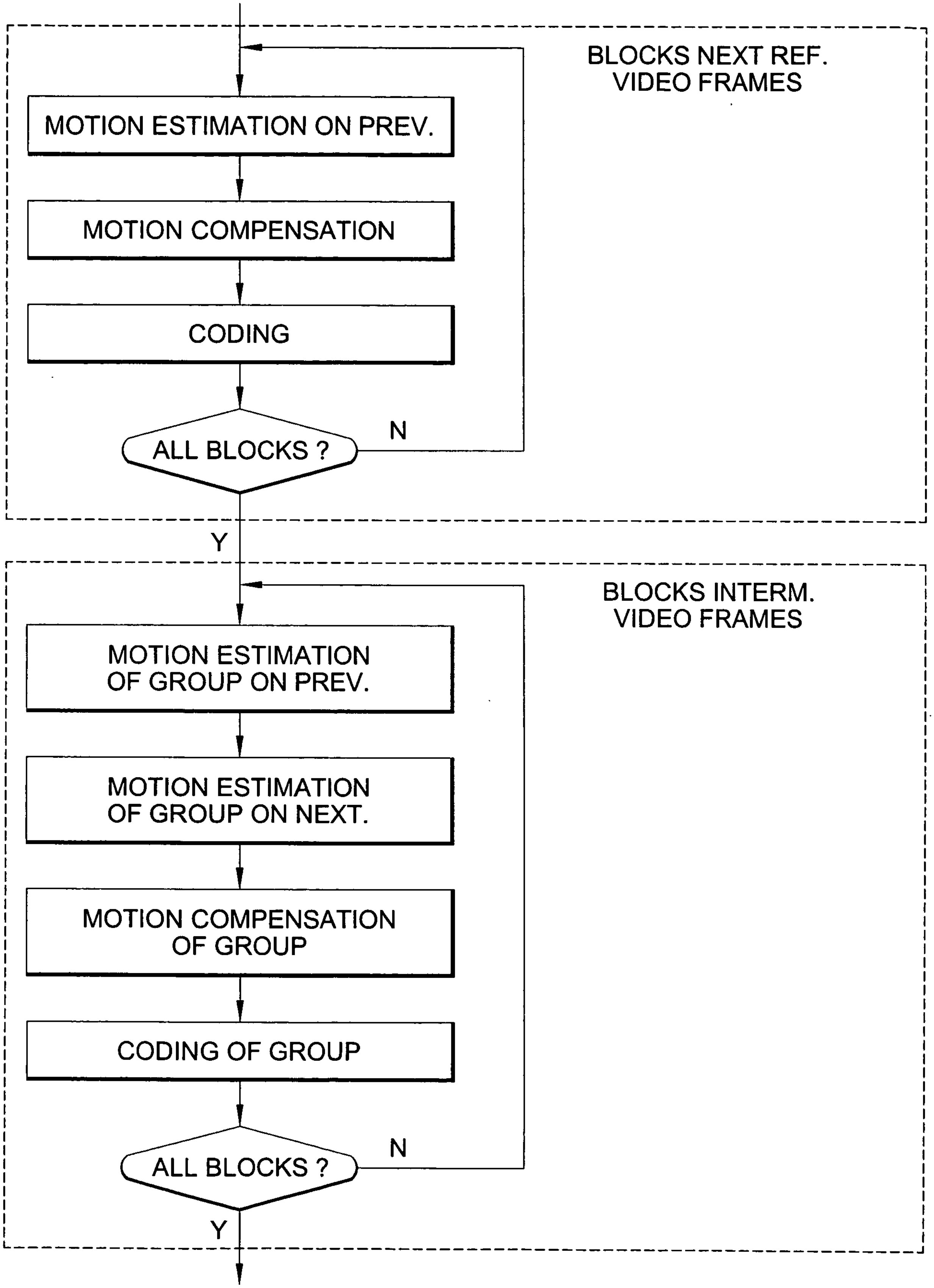

BLOCKS NEXT REF. VIDEO FRAMES
MOTION ESTIMATION ON PREV.
MOTION COMPENSATION
CODING
ALL BLOCKS ?
N
Y
BLOCKS INTERM. VIDEO FRAMES
MOTION ESTIMATION OF GROUP ON PREV.
MOTION ESTIMATION OF GROUP ON NEXT.
MOTION COMPENSATION OF GROUP
CODING OF GROUP
ALL BLOCKS ?
N
Y

FIG. 12

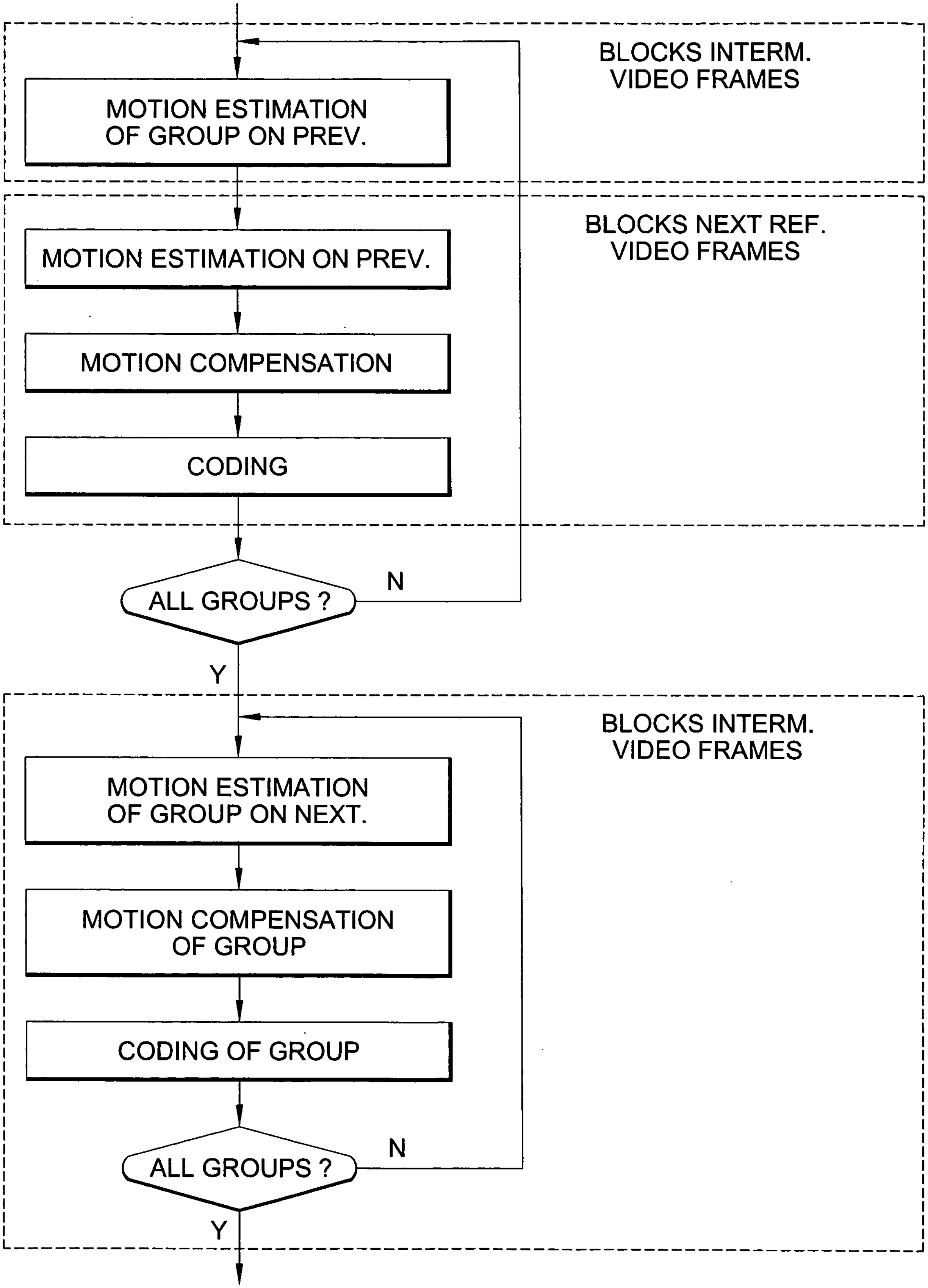

BLOCKS INTERM. VIDEO FRAMES
MOTION ESTIMATION OF GROUP ON PREV.
BLOCKS NEXT REF. VIDEO FRAMES
MOTION ESTIMATION ON PREV.
MOTION COMPENSATION
CODING
ALL GROUPS ?
N
Y
BLOCKS INTERM. VIDEO FRAMES
MOTION ESTIMATION OF GROUP ON NEXT.
MOTION COMPENSATION OF GROUP
CODING OF GROUP
ALL GROUPS ?
N
Y

FIG. 13

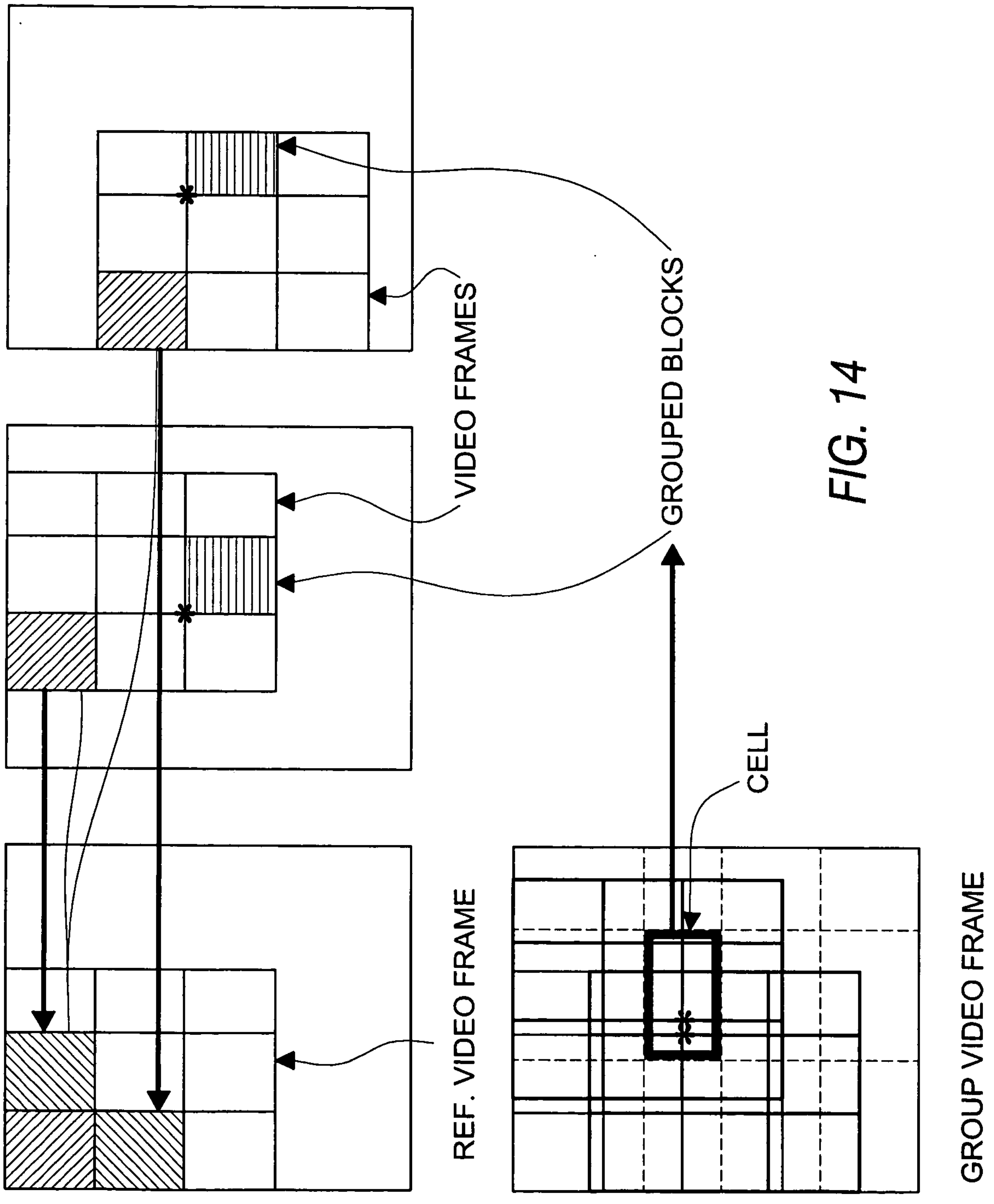

VIDEO FRAMES
GROUPED BLOCKS
CELL
REF. VIDEO FRAME
GROUP VIDEO FRAME

FIG. 14

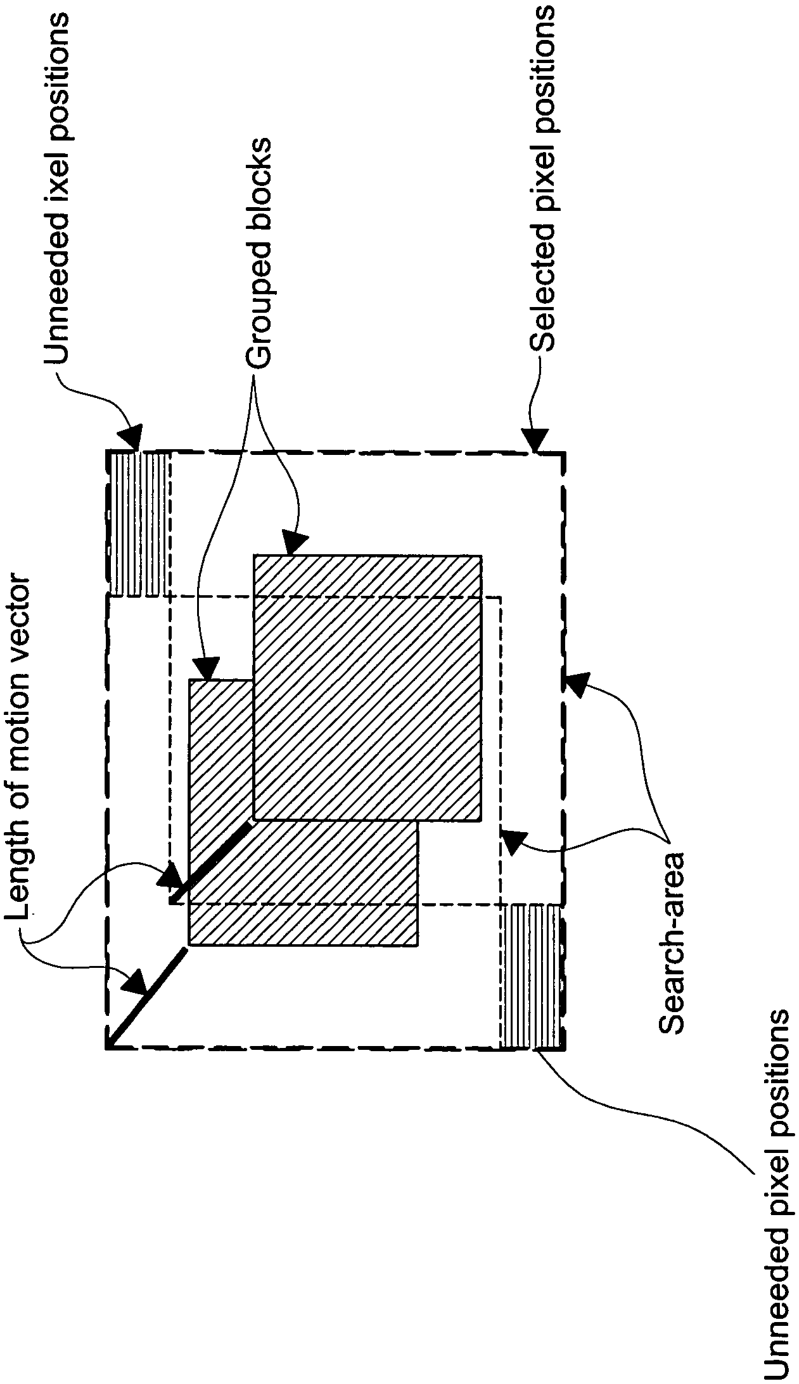

Unneeded ixel positions
Grouped blocks
Selected pixel positions
Length of motion vector
Search-area
Unneeded pixel positions

FIG. 15

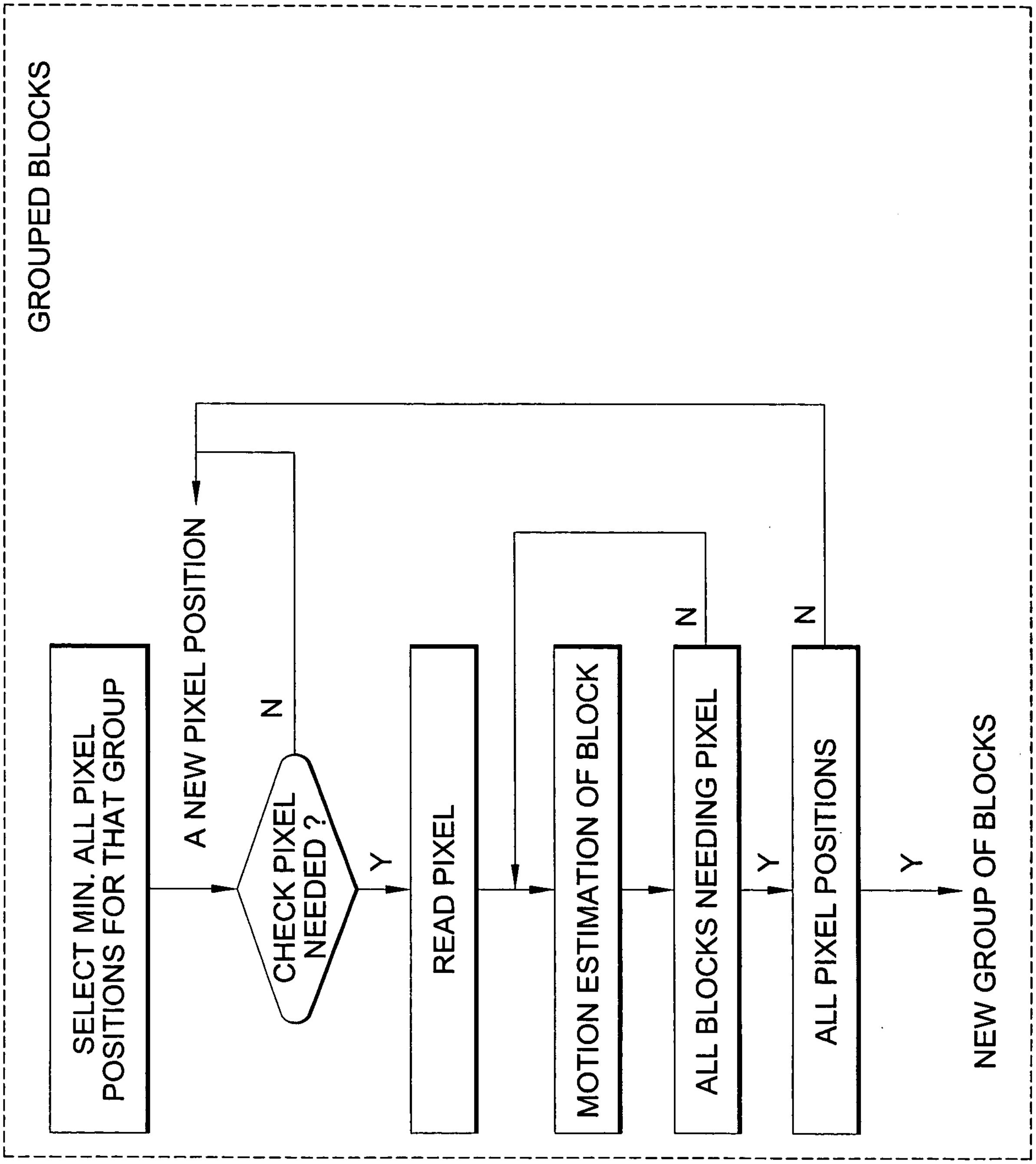

GROUPED BLOCKS
SELECT MIN. ALL PIXEL POSITIONS FOR THAT GROUP
A NEW PIXEL POSITION
CHECK PIXEL NEEDED ?
N
Y
READ PIXEL
MOTION ESTIMATION OF BLOCK
ALL BLOCKS NEEDING PIXEL
N
Y
ALL PIXEL POSITIONS
N
Y
NEW GROUP OF BLOCKS

FIG. 16

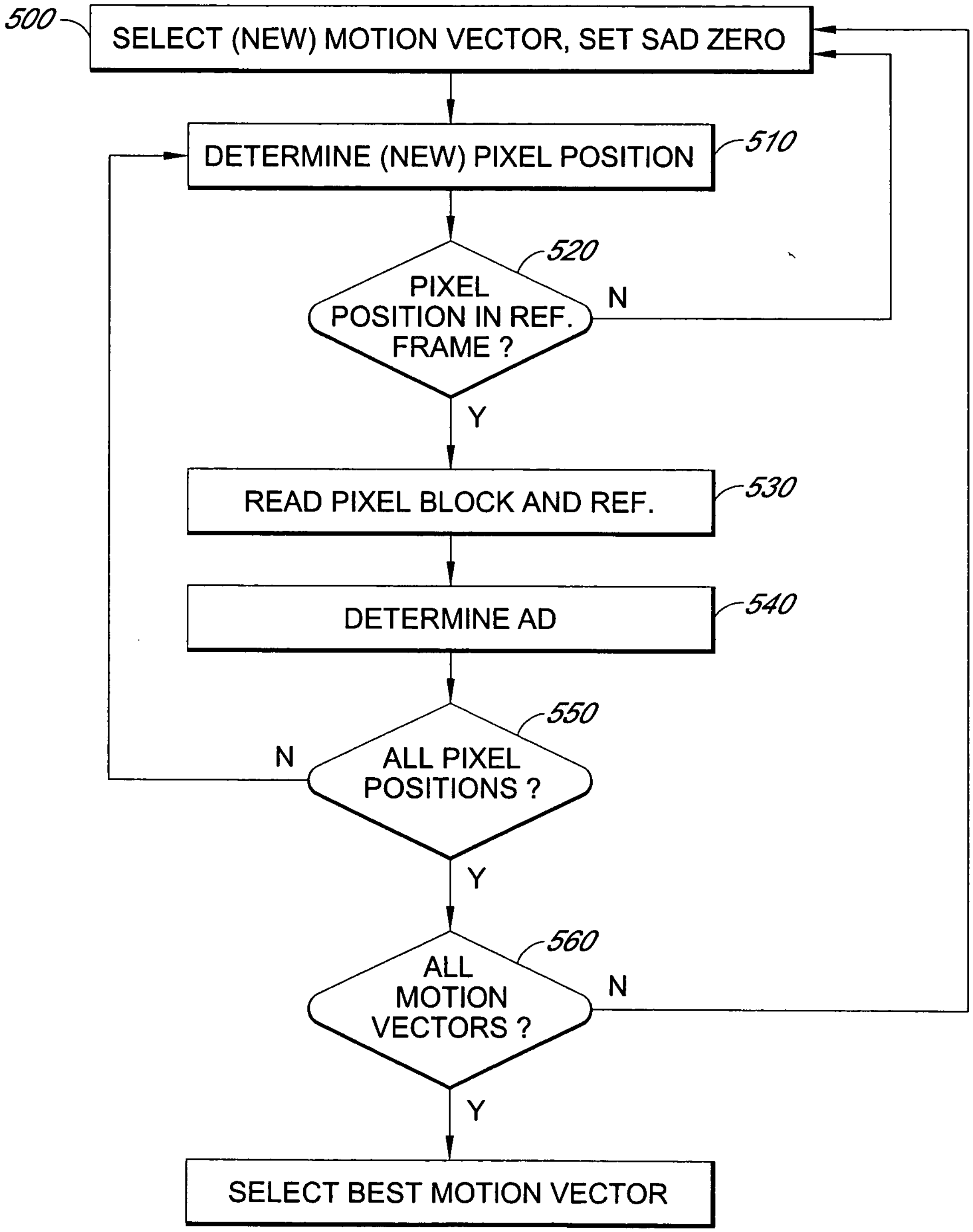

500
SELECT (NEW) MOTION VECTOR, SET SAD ZERO
510
DETERMINE (NEW) PIXEL POSITION
520
PIXEL POSITION IN REF. FRAME ?
N
Y
530
READ PIXEL BLOCK AND REF.
540
DETERMINE AD
550
ALL PIXEL POSITIONS ?
N
Y
560
ALL MOTION VECTORS ?
N
Y
SELECT BEST MOTION VECTOR

FIG. 17

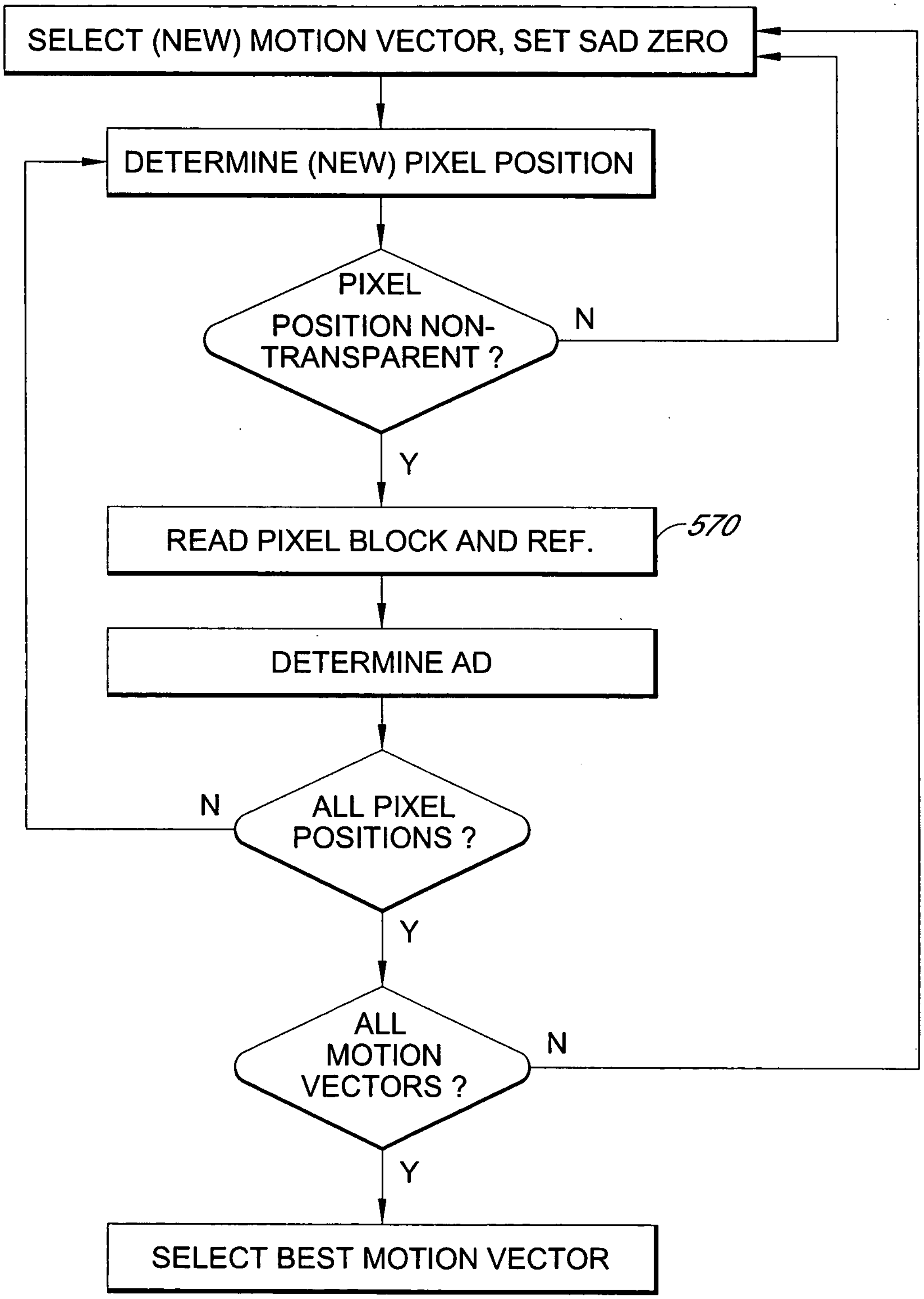

SELECT (NEW) MOTION VECTOR, SET SAD ZERO
DETERMINE (NEW) PIXEL POSITION
PIXEL POSITION NON-TRANSPARENT ?
N
Y
READ PIXEL BLOCK AND REF.
570
DETERMINE AD
ALL PIXEL POSITIONS ?
N
Y
ALL MOTION VECTORS ?
N
Y
SELECT BEST MOTION VECTOR

FIG. 18

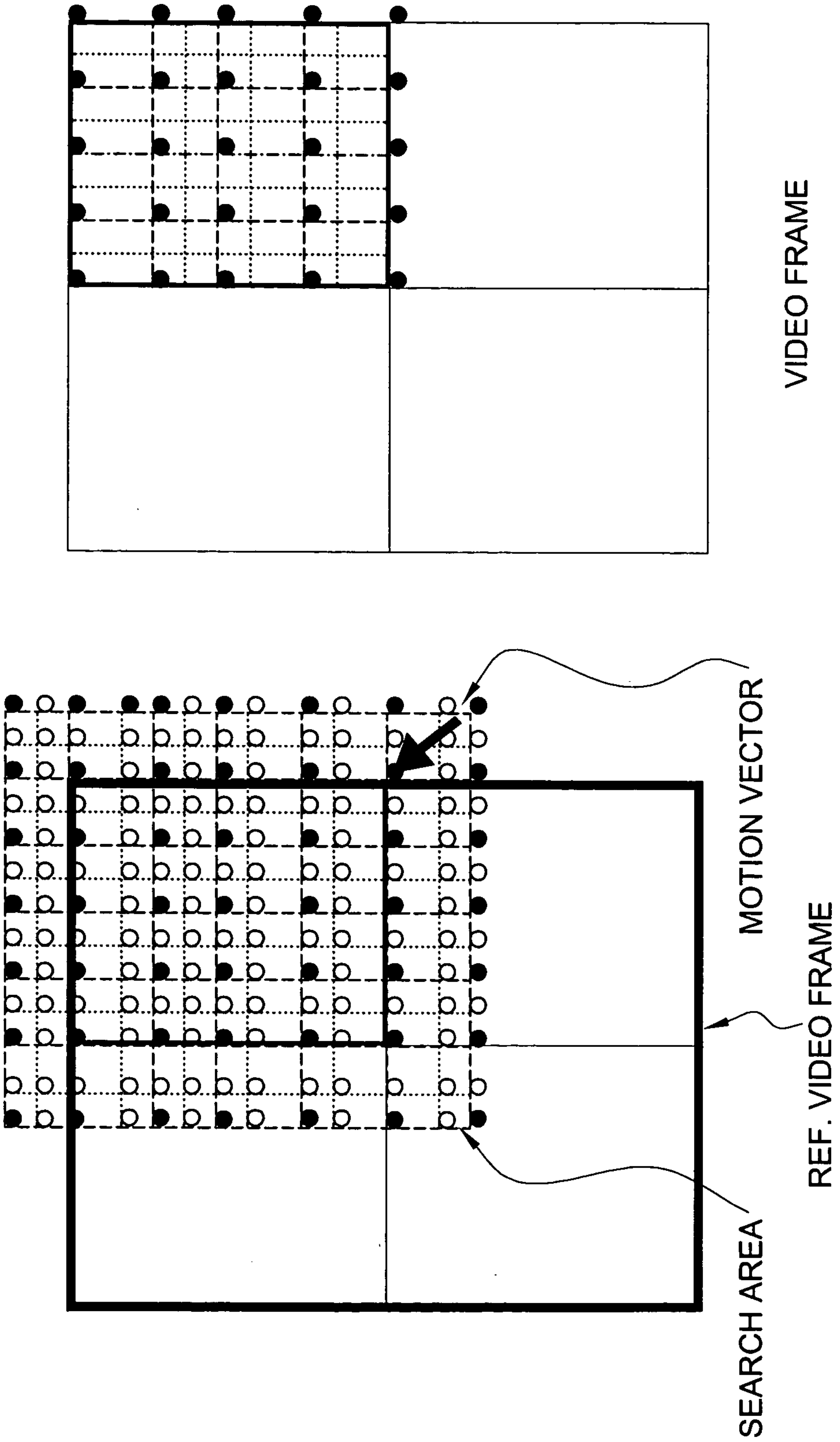


FIG. 19

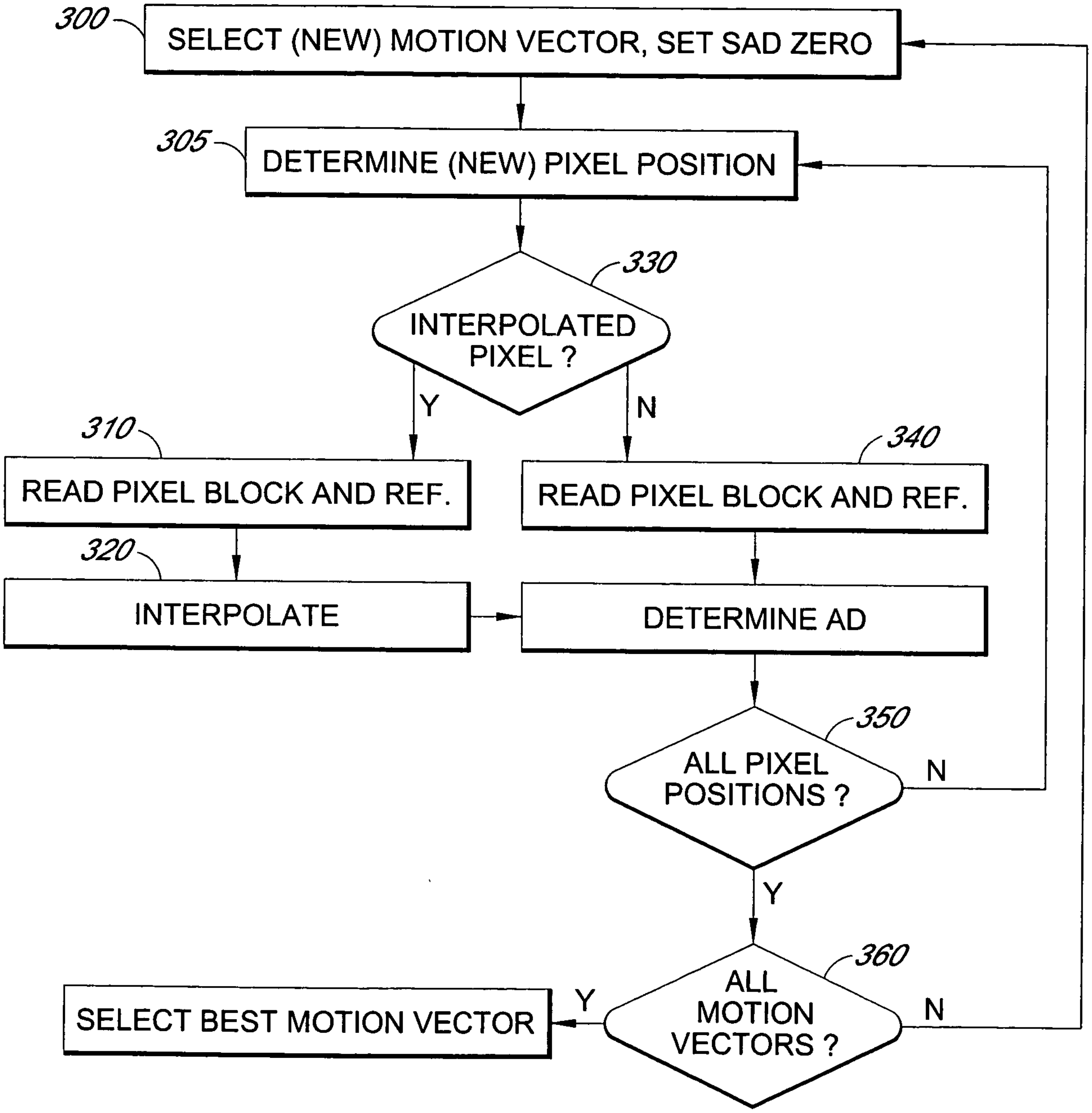

300
SELECT (NEW) MOTION VECTOR, SET SAD ZERO
305
DETERMINE (NEW) PIXEL POSITION
330
INTERPOLATED PIXEL ?
Y
N
310
READ PIXEL BLOCK AND REF.
340
READ PIXEL BLOCK AND REF.
320
INTERPOLATE
DETERMINE AD
350
ALL PIXEL POSITIONS ?
N
Y
360
ALL MOTION VECTORS ?
Y
N
SELECT BEST MOTION VECTOR

FIG. 20

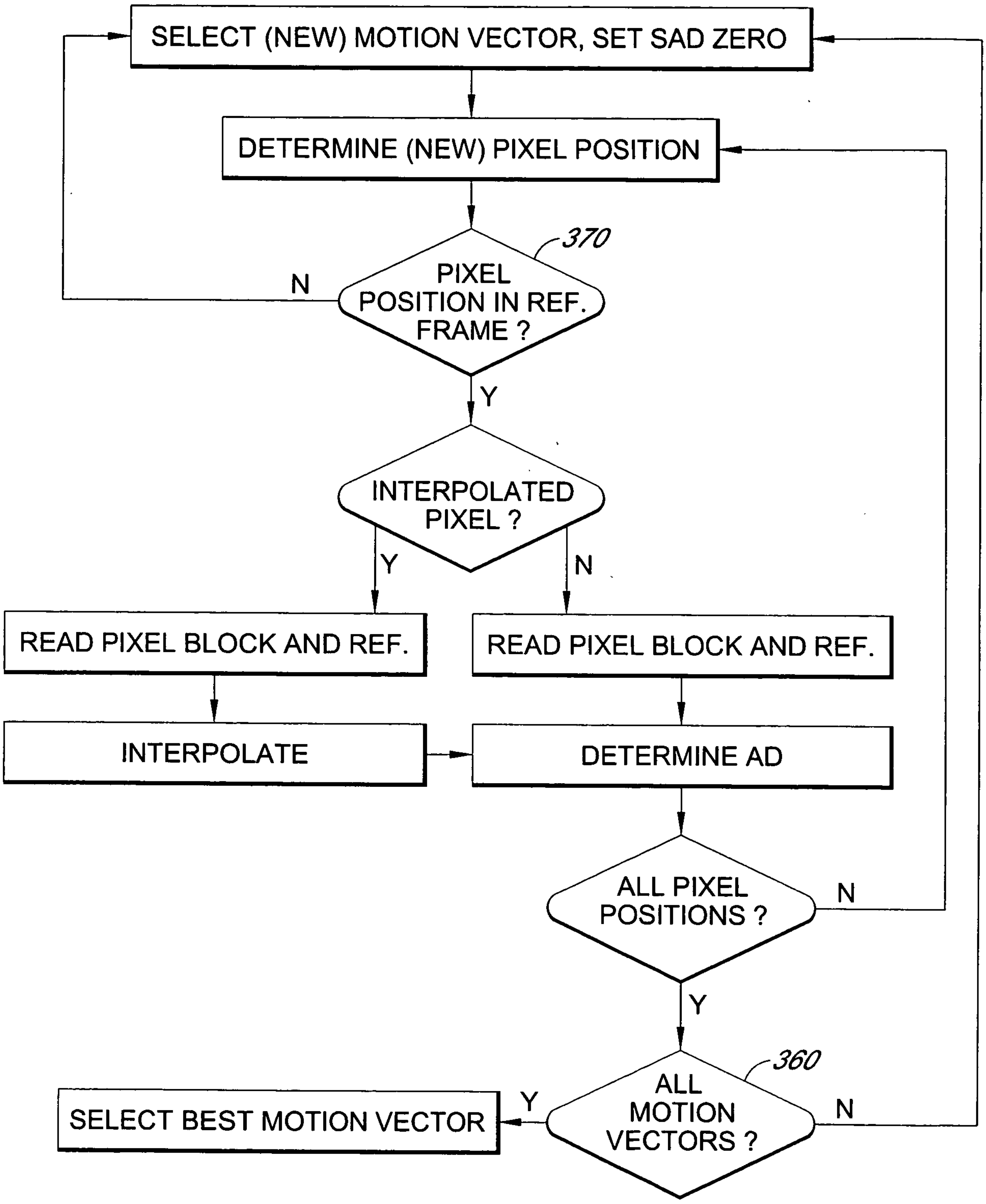

SELECT (NEW) MOTION VECTOR, SET SAD ZERO
DETERMINE (NEW) PIXEL POSITION
370
PIXEL POSITION IN REF. FRAME ?
N
Y
INTERPOLATED PIXEL ?
Y
N
READ PIXEL BLOCK AND REF.
READ PIXEL BLOCK AND REF.
INTERPOLATE
DETERMINE AD
ALL PIXEL POSITIONS ?
N
Y
360
ALL MOTION VECTORS ?
Y
N
SELECT BEST MOTION VECTOR

FIG. 21

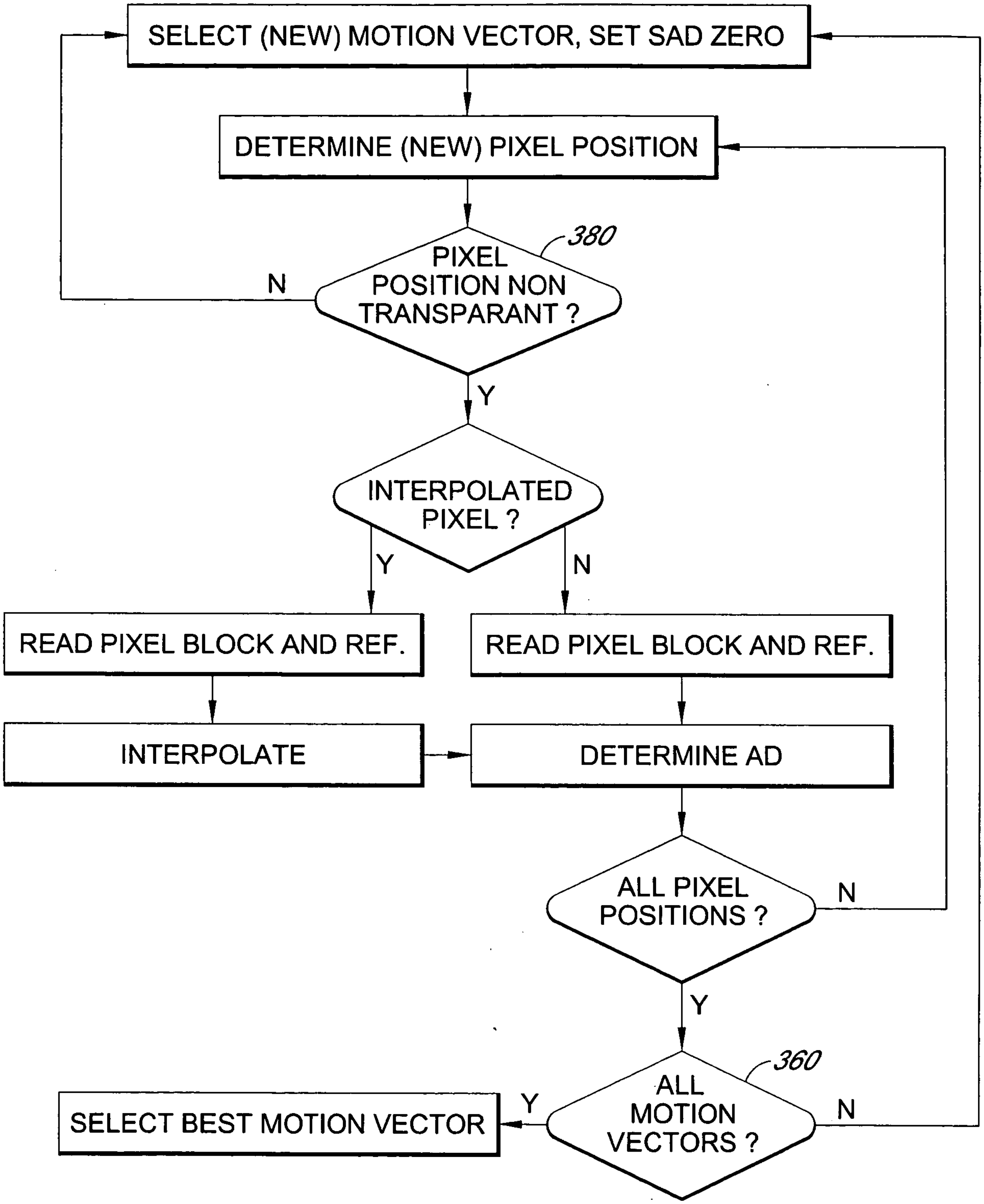

SELECT (NEW) MOTION VECTOR, SET SAD ZERO
DETERMINE (NEW) PIXEL POSITION
380
PIXEL POSITION NON TRANSPARANT ?
N
Y
INTERPOLATED PIXEL ?
Y
N
READ PIXEL BLOCK AND REF.
READ PIXEL BLOCK AND REF.
INTERPOLATE
DETERMINE AD
ALL PIXEL POSITIONS ?
N
Y
360
ALL MOTION VECTORS ?
Y
N
SELECT BEST MOTION VECTOR

FIG. 22

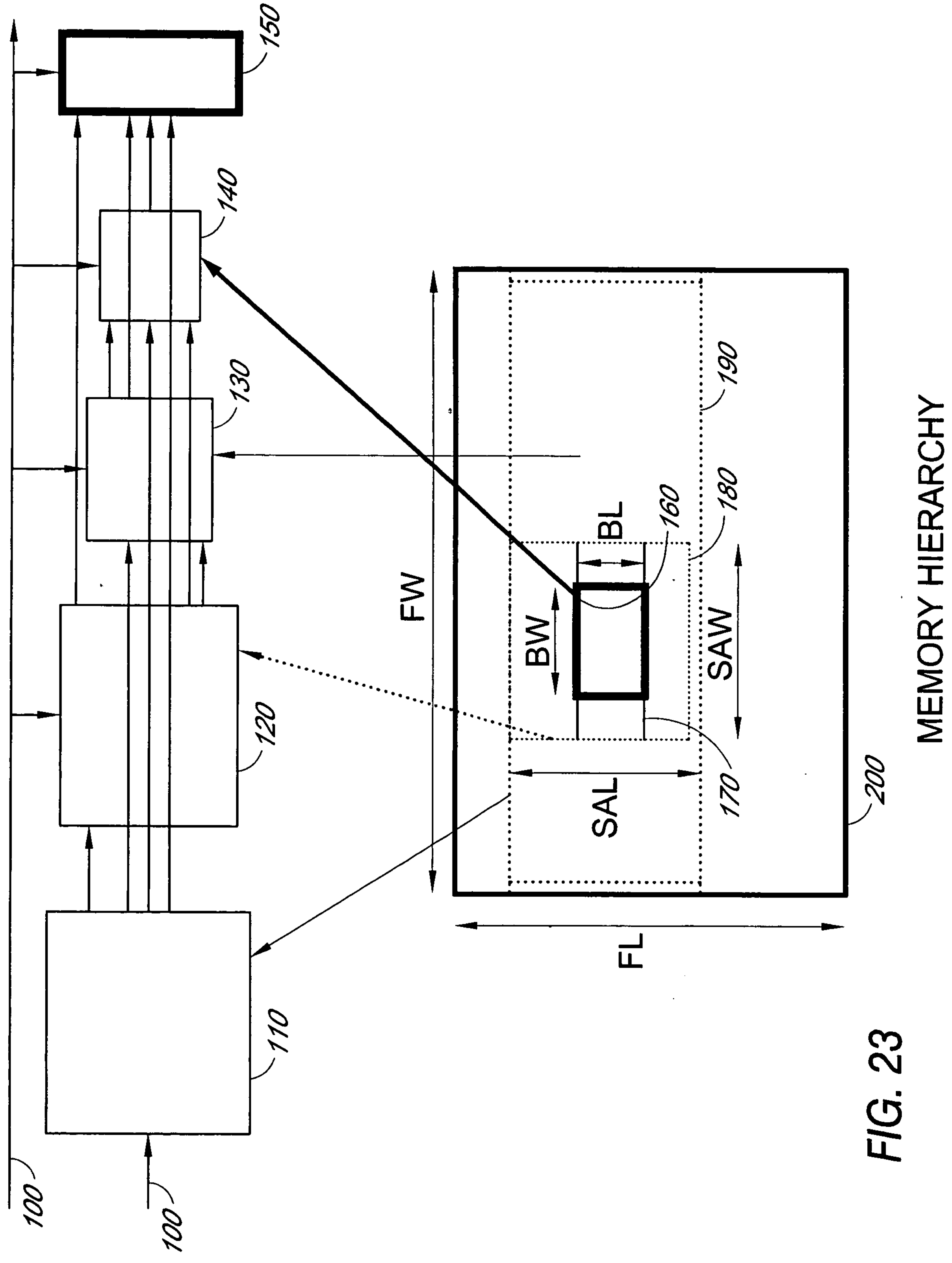
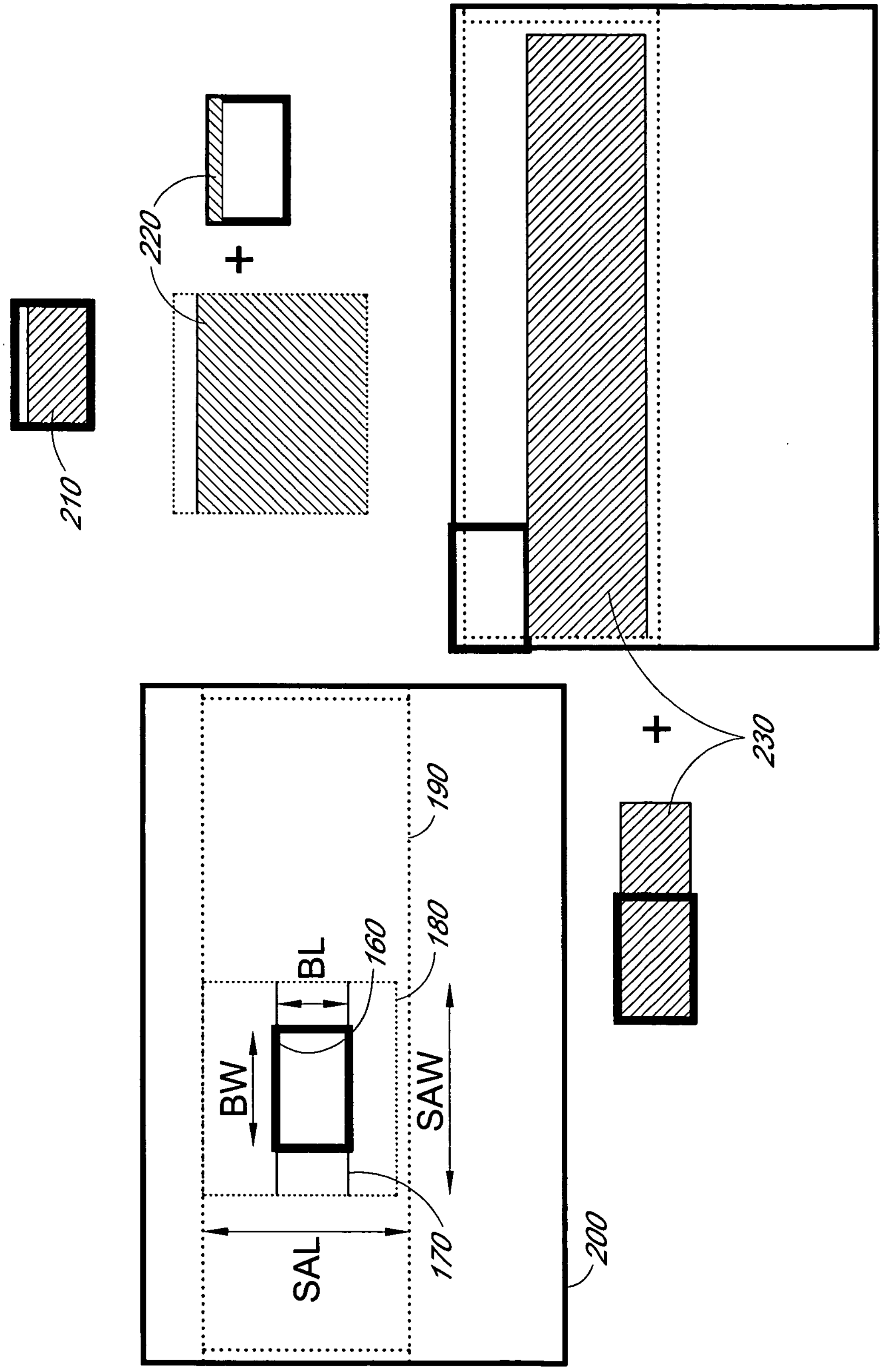

150
140
130
120
110
100
100
FW
FL
BW
BL
SAW
SAL
160
170
180
190
200
MEMORY HIERARCHY

FIG. 23



MEMORY SIZES

FIG. 24